A METHOD FOR TRANSMITTING LOCATION INFORMATION ON A DIGITAL MAP, APPARATUS FOR IMPLEMENTING THE METHOD, AND TRAFFIC INFORMATION PROVISION/RECEPTION SYSTEM

BACKGROUND OF THE INVENTION

1.Field of the Invention

The present invention relates to an information transmission method for transmitting location information such as traffic jams and accidents for example in a traffic information provision system and apparatus for exchanging location information using the method, and in particular to such a method and apparatus that can correctly report a location on a digital map.

2.Description of the Related Art

In recent years, the number of vehicles that have car-mounted navigation apparatus has been increasing rapidly. The car-mounted navigation system has a digital map database and is capable of displaying the map around the vehicle on a screen based on the latitude/longitude data received by a GPS receiver as well as displaying the travel locus and the result of search for a route to the destination on the map.

In Japan, digital map databases are prepared by several companies. The problem is that map data contains errors inherent

in the reduced-scale map. The errors depend on individual digital maps. Some of the maps on the market drawn on the scale of 1:25000 contain errors of about 50 meters depending on the location.

Latitude/Longitude data obtained from a GPS receiver may contain errors of several tens of meters.

Some models of car-mounted navigation apparatus on the market receives traffic jam information and accident information from a traffic information provision system and displays the traffic jam and accident locations on the map or performs route search using such information as additional search conditions.

In a related art traffic information provision system, as shown in Fig. 7, traffic information is provided from a traffic information collecting center 71 that has local jurisdiction over an area to an information delivery center 72. Traffic information edited for each transmission medium including FM broadcasts, road beacons and cell phones is transmitted via respective media.

The traffic information collecting center 71 exchanges traffic information with a traffic information collecting center 78 in other areas to collect traffic information in a wide service area including the peripheral areas.

In the traffic information, for example, in case latitude/longitude data on the location is presented alone in order to report a traffic jam location or accident location, various errors are contained depending on the kind of digital

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map database of the car-mounted navigation apparatus as mentioned earlier. Thus, different accident locations on the road could be recognized by the car-mounted navigation apparatus retaining a digital map database from Company A and the car-mounted navigation apparatus retaining a digital map database from Company B.

In order to alleviate incorrect information transmission, as shown in Fig. 8A, crossings a and b on a road network are assumed as nodes, and a road c connecting the nodes as a link. Each node is assigned a node number uniquely representing the node (a=1111, b=3333). Each link is assigned a link number uniquely representing the link (c=11113333). In the digital map database of each company, the node numbers and link numbers thus assigned are stored, in correspondence with each crossing and road.

In traffic information provision service, a point on the road is represented by first specifying a link number then the distance in meters from the start of the link. For example, a display "Location 200 meters from the start of the road with link number=11113333 " allows the user to obtain the location P on the same road by tracing the road with link number=11113333 as far as 200 meters from the node with node number 1111, irrespective of what digital map data is used by the car-mounted navigation system in question.

Node numbers and link numbers defined on a road network must be changed to new numbers in case a road d is constructed or a road is modified as shown in Fig. 8B. Such modifications to node numbers and link numbers require updating of digital

map data from each company.

Construction of or modification to a road continue into the future. As long as on-road location representation is made using node numbers and link numbers, maintenance of digital map databases is permanently accompanied by huge workload and resulting costs.

The information delivery center must send information that complies with past node numbers and link numbers for a predetermined period, for example three to five years, as well as the information of the latest year, in order to support navigation systems sold in the past. This causes huge maintenance workload.

SUMMARY OF THE INVENTION

The invention solves such related art problems and aims at providing a location information transmission method that can transmit a location on a digital map without excessive maintenance workload and apparatus for implementing the method.

In a location information transmission method according to the invention, an information provider transmits on-road location information by using road shape data consisting of a string of coordinates representing the road shape of a road section having a length that depends on the situation and relative data indicating the on-road location in the road section. A party receiving the on-road location information performs shape matching

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to identify the road section on the digital map and uses relative data to identify the on-road location in this road section.

In location information transmission apparatus according to the invention, apparatus at an information provider comprises a location information converter for converting transmit on-road location information to road shape data consisting of a string of coordinates representing the road shape of a road section having a length that depends on the situation and relative data indicating the on-road location in the road section. Apparatus at a party that receives the on-road location information comprises a shape matching section for performing shape matching by using the received road shape data, identifying the road section on a digital map and identifying the on-road location in the road section by using the relative data.

Thus, it is possible to correctly transmit a location on a digital map as well as the travel direction of the vehicle without defining node numbers or link numbers on a road network.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram showing a configuration of location information transmission apparatus in the first embodiment of the invention.

Fig. 2 is a flowchart showing the operation of location information transmission apparatus in the first embodiment of

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the invention.

Fig. 3 is an explanatory drawing illustrating road shape data and distance data constituting the road location information.

Fig. 4 is an explanatory drawing showing an example of shape matching.

Fig. 5 is a block diagram showing a configuration of location information transmission apparatus in the second embodiment of the invention.

Fig. 6 is a block diagram showing another configuration of location information transmission apparatus in the second embodiment.

Fig. 7 is an explanatory drawing showing a traffic information provision system.

Fig. 8A is an explanatory drawing of node numbers and link numbers.

Fig. 8B is an explanatory drawing of modifications to node numbers and link numbers made when a new road is constructed.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The first aspect of the invention is a location information transmission method for transmitting on-road location on a digital map, characterized in that an information provider transmits on-road location information by using road shape data including the on-road location information consisting of a string of coordinates representing the road shape of a road section having

a length that depends on the situation and relative data indicating the on-road location in the road section and that a party receiving the on-road location information performs shape matching to identify the road section on the digital map and uses the relative data to identify the on-road location in the road section. This makes it possible to correctly report a location on a digital map without defining node numbers or link numbers on a road network.

The second aspect of the invention uses a string of coordinates arranging latitude/longitude data of the road point per predetermined distance interval as a string of coordinates representing the road shape. A party receiving the on-road location information uses the latitude/longitude data of each point to perform shape matching thus identifying the road section having the same road shape.

The third aspect of the invention uses distance data from a specific point in the road section as the relative data. A party receiving the on-road location information uses the distance data to identify the on-road location after identifying the road section.

The fourth aspect of the invention is location information transmission apparatus for exchanging information about the on-road location on a digital map, characterized in that apparatus at an information provider comprises a location information converter for converting transmit on-road location information to road shape data including the on-road location consisting

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of a string of coordinates representing the road shape of a road section having a length that depends on the situation and relative data indicating the on-road location in the road section, and that apparatus at a party receiving the on-road location information comprises a shape matching section for performing shape matching by using the road shape data, identifying the road section on a digital map and identifying the on-road location in the road section by using the relative data. This makes it possible to correctly exchange information about the location on a digital map without defining node numbers or link numbers on a road network.

The fifth aspect of the invention uses a string of coordinates arranging latitude/longitude data of the road point per predetermined distance interval as a string of coordinates representing the road shape. The shape matching section of the apparatus at a party receiving the on-road location information uses the latitude/longitude data of each road point to perform shape matching thus identifying the road section having the same road shape.

The sixth aspect of the invention uses distance data from a specific point in the road section as the relative data. The shape matching section of the apparatus at a party receiving the on-road location information uses the distance data to identify the on-road location after identifying the road section.

The seventh aspect of the invention is a traffic information provision/reception system to which location information

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transmission apparatus according to the fourth aspect of the invention is applied. This makes it possible to correctly report the location on a digital map without using node numbers or link numbers.

The eighth aspect of the invention is characterized in that apparatus at the information provider is a center for collecting traffic information in the area and that apparatus at the party receiving the on-road location information is a center for collecting traffic information in other areas. This makes it possible to use the location information transmission method for exchange of traffic information between centers.

The ninth aspect of the invention is characterized in that apparatus at the information provider is an infrastructure for providing traffic information and that apparatus at the party receiving the on-road location information is a car-mounted navigation apparatus. This makes it possible to use the location information transmission method for information provision to car-mounted navigation apparatus.

Embodiments of the invention will be described referring to the drawings.

(First embodiment)

In the first embodiment, a location information transmission method according to the invention will be described taking as an example the case where traffic information is exchanged between traffic information collecting centers in Fig. 7

The traffic information collecting center A, as shown in

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Fig. 1, comprises an event information input section 1 for inputting event information such as traffic accidents and traffic jams, a location information converter 2 for generating location information representing the event location, a location information transmitter 3 for transmitting the generated location information, a location information receiver 6 for receiving the location information, a shape matching section 5 for performing shape matching and identifying the event location from the location information, a digital map display section 4 for displaying the event location on a map, and a digital map database 7. The traffic information collecting center B has the same configuration as the traffic information collecting center A.

Operation flow of the traffic information collecting center is shown in Fig. 2.

(Step 1:) When an event such as a traffic accident or a traffic jam takes place, (Step 2:) The event details and the event location information are input to the event information input section 1 of the traffic information collecting center. For example, when information indicating occurrence of a traffic jam is input to a vehicle detector installed on the road, (Step 3:) the location information converter 2 generates road shape data including traffic jam location consisting of a string of coordinates representing the road shape of a road section having a predetermined length and distance data indicating the distance from the start point of the road section to the traffic jam location, in order to report the traffic jam information to the traffic information

collecting center B.

Fig. 3 is a schematic view showing the location information generated by the location information converter 2. In case a traffic jam has occurred in the section A to B on the road, the road shape of the road including the section is represented in a string of coordinates consisting of 601 points in 5-meter intervals, P_0 (x_0, y_0), P_1(x_1, y_1), ... , p_{600}(x_{600}, y_{600}). Here, x_k and y_k are latitude and longitude data, respectively, of the on-road point p_k acquired from the digital database 7. Further, the distance l_1 from the point P_0(x_0, y_0) to the traffic jam start point A and the distance l_2 from the point P_0(x_0, y_0) to the traffic jam end point B are obtained and the road shape data : (x_0, y_0) (x_1, y_1) ...(x_{600}, y_{600}) and traffic jam distance data: l_1 to l_2 m are generated as location information.

Rank information indicating the degree of traffic jam and information indicating the type of a digital map database used are added to the location information to create transmit information, and (Step 4:) the location information transmitter 3 transmits the information to the traffic information collecting center B.

(Step 5:) In the traffic information collecting center, receiving the information at the location information receiver 6, (Step 6:) the shape matching section 5 performs shape matching of map data in the digital map database 7 and the string of coordinates indicating the road shape to identify the road section on the

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digital map, then identifies the traffic jam section on the digital map based on the distance data from the start point of the road section.

Fig. 4 shows an example of shape matching.

Roads Q and R included within the error range around the P_0 (x_0, y_0) point of map data read from the digital map database 7 are selected as candidates.

Then, locations Q_0, R_0 on each candidate road closest to P_0 (x_0, y_0) are obtained and distance P_0-Q_0 and distance P_0-R_0 are calculated.

This operation is carried out for each point P_0 (x_0, y_0), P_1 (x_1, y_1), ... , P_{600} (x_{600}, y_{600}) and the road section where the summation value of the root mean square of the distances from each point P_0, P_1, ... , P_{600} is smallest is obtained.

Then the section l_1-l_2 m from the start point of the road section is identified as a traffic jam section.

(Step 7:) The digital map display section 4 reads data from the digital map database 7 and displays a map, then paints the colors corresponding to the traffic jam levels in the traffic jam section obtained by the shape matching section 5.

In this way, the party receiving information can perform shape matching and identify the road section having the road shape without defining node numbers or link numbers, when the information provider represents the road shape using a string of coordinates.

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While the interval of points used to indicate the shape of the road section is 5 meters and the number of points is 601 in this embodiment, the interval and the number are not intended to limit the invention.

While latitude and longitude data is used as coordinate data in a string of coordinates in this embodiment, other coordinate data may be used so long as the data can be shared by the information provider and the information receiver.

By adding effective auxiliary information to the transmit location information, it is possible to enhance the efficiency of shape matching at the receiving party.

As a shape matching algorithm, a method other than the illustrated least square method may be used.

(Second embodiment)

In the second embodiment, transmission of location information between the infrastructure of the traffic information provision system (information provider) and the car-mounted navigation apparatus will be described.

Here, infrastructure refers to such social infrastructures as broadcasting stations, traffic signs, traffic signal lights or traffic monitoring cameras and so on. The social infrastructures may involve centers to control the forementioned stations, signs or other elements that are parts of the infrastructure.

Fig. 5 shows an infrastructure 51 that provides information and car-mounted navigation apparatus 61 that receives information.

The infrastructure 51 comprises an event information input section 52 for inputting event information, a location information converter 53 for generating location information representing the event location, a location information transmitter 54 for transmitting the generated location information, a digital map display section 55, and a digital map database 56.

The car-mounted navigation apparatus 61 comprises a location information receiver 62 for receiving location information, a shape matching section 63 for performing shape matching and identifying the event location from the location information, a digital map display section 64 for displaying the event location on a map, and a digital map database 65.

Operation of the infrastructure is the same as the operation of step 1 through step 4 of Fig. 2. Operation of the car-mounted navigation apparatus is the same as the operation of step 5 through step 7 of Fig. 2.

In the traffic information provision system, the infrastructure provides information including the string of coordinates of the road section of a predetermined length including the event location and the information on the event location that uses the road section as a reference, via FM broadcasts and beacons. The car-mounted navigation apparatus identifies the road section from the string of coordinates and identifies the event location by using the road section as a reference. Thus, it is possible to correctly report the location on a digital map without defining node numbers or link numbers.

Fig. 6 shows a case where the car-mounted navigation apparatus comprises an event information input section, a location information converter, a location information transmitter, a location information receiver, a shape matching section, a digital map display section, and a digital map database. The car-mounted navigation apparatus can transmit the accident location to the infrastructure if an accident takes place.

In this practice, the car-mounted navigation apparatus acquires from the digital map database coordinate data of a plurality of locations in the road section of a predetermined length including the accident location. Then the car-mounted navigation apparatus transmits the coordinate data and information on the event location using the road section as a reference. The center receives the information and performs shape matching to identify the road section from the road shape, then identifies the accident location.

As understood from the foregoing description, a location information transmission method and apparatus can correctly report the location on a digital map to a distant party without using node numbers or link numbers on a road network.

With this method, it is possible to substantially reduce workload and costs for maintenance of digital map databases thus reducing the socials costs for maintaining the traffic information provision system.